The Science of Superheroes

Week 1: Super Spiders

OBJECTIVES:

- Students will recognize what distinguishes spiders from other animals
- Students will understand how spiders and some other animals walk on walls
- Students will understand the properties of non-newtonian fluids

STANDARDS MET:

7th Grade: 7.PS.2 Describe the properties of solids, liquids, and gases. Develop models that predict and describe changes in particle motion, density, temperature, and state of a pure substance when thermal energy is added or removed.
7.ESS.6 Research common synthetic materials (i.e. plastics, composites, polyester, and alloys) to gain an understanding that synthetic materials do come from natural resources and have an impact on society.
8th Grade: 8.PS.6 Compare and contrast physical change vs. chemical change. Analyze the properties of substances before and after substances interact to determine if a chemical reaction has occurred.
8.LS.9 Examine traits of individuals within a species that may give them an advantage or disadvantage to survive and reproduce in stable or changing environment

VOCABULARY:

- Arthropod: a phylum of invertebrate animal that has an exoskeleton, segmented legs, and a segmented body.
- Invertebrate: an animal without a backbone
- Exoskeleton: made of a material called chitin. The supporting structure of the animal on the outside of the body.
- Abdomen: the lower segment of a spider. The spinnerets are attached to this segment.
- Cephalothorax: the combined head and thorax of a spider. This is where legs, eyes, fangs, and pedipalps are
- Pedipalp: leg like structure near the fangs used to hold prey.

MATERIALS:

- Cardstock for name plates
- Markers

Spider Observation:

- Jars with live spiders. (they can be collected from outside in the summer, spring and fall, or from houses and buildings during the winter. Spiders can also be ordered online from companies such as Carolina).
- Notebook paper
- Pencils (one for each student)
- Hand lenses (one for each student)

Surface Tension:

- Small dessert sized plates (one for each student)
- Pepper (1 t per group)
- Toothpicks 2-3 for each student.
- Dish soap (1 T per group).
- 6 100 ml beakers
- 6 500 ml beakers

Sand Castles:

- 12 9x9 baking trays (foil is fine).
- 3 lb bag regular play sand (make sure it is dry before class starts)
- 3 lb bag magic (hydrophobic) sand (Make sure you **do not** get kinetic sand)

Non-newtonian fluid

- Food coloring
- 1 box borax
- 6 cups glue
- Ziplock bags (one per student)
- 1000 ml beaker
- 12 500 ml beakers
- 6 200 ml beakers
- Sharpie
- 6 graduated cylander
- Plastic spoons

CLASS SET-UP:

- Have the name tags and sign in sheet set up on the back table.
- Before class begins, make sure each table has four pieces of cardstock and a box of markers so that students can create nameplates for themselves.
- Prepare 6 trays with regular sand. Label all regular sand as Tray 1.
- Prepare 6 trays with magic sand. Label all magic sand as Tray 2.
- Set both sand trays off to the side of the room.
- Add 4 cups of ml to the 1000 ml beaker. Stir in 2 Tablespoons of Borax

TEACHING TIMELINE:

Introduction:	10 minutes
What is a spider:	30 minutes
Walking on Walls:	60 minutes
Spider webs:	50 minutes

RULES:

1. Respect (teacher, classmates, animals, and environment)
2. Follow all instructions

INTRODUCTION:

(As students arrive, have them create a nameplate. They can work on them while waiting for everyone to show up. Tell them to fold it in half so they have a little tent. On one side, write I real name. On the other side, write their superhero name that they would choose if they were a superhero. Try to make up I own name. For example, they can't say they want to be Batman. They can think about what power they would have and then come up with a name that goes along with it. They may decorate both sides of the nameplate as they desire, but make sure the real name is readable from a distance. I would suggest coming up with a superhero symbol to go along with the name, but it is not necessary.)

Introduction:

Welcome the class. "How many of you saw the Justice League movie when it came out a few months ago? Thor: Ragnorak? Spider-man Homecoming? Did you like them?

"I love superheroes. I have seen almost every Marvel movie that has been released and I love reading comic books. It is fun to think about what it would be like to have amazing powers. Over the next five weeks, we are going to examine the science behind a few different superheroes. We may hit on some of your favorites but we may not. There are many superheroes out there and we have a very limited time. But before we begin, we need to get to know each other first."

Go around the room. Have every student share his or her name, the superpower they would have, and their superhero name. After everyone has introduced themselves, explain that their table will be like their superhero team. They will be working together on projects and activities over the five weeks.

"The first superhero we will talk about is the number one grossing superhero of all time: Spider-man (CBS news). For those of you unfamiliar with Spider-man, his real name is Peter Parker. After he was bitten by a radioactive spider, he gained the abilities of a spider: can stick to walls, is very strong, has a "spidey sense" that tells him when danger is near. He is also super smart and created web shooters and a synthetic spider web that allows him to swing through New York City and attack and tie up the bad guys. He decided to use his powers to help people after his inaction indirectly lead to his Uncle Ben getting shot. After all, "with great power, comes great responsibility."

What is a spider:

"So how many of his powers are actually things that spiders can do? What is a spider?" Have the students call out characteristics of spiders. Write them on the board as they are named.

"Over the past few days, I have been collecting spiders from around the house and buildings. Each table will have a jar with a spider in it. As a team, you will work together to make observations of your spider. Write down everything that you can see about the spider. Please keep the spider in the jar. It is a living thing and needs to be respected. You are more powerful than that spider so need to take responsibility for the wellbeing of the creature." Give the students 10 minutes to make observations and their spider sketch. (idea from Smithsonian Education)

After ten minutes talk about some of the observations that were made. Talk about physical characteristics of spiders first. "They are arthropods. Arthropods are invertebrates with segmented legs, segmented bodies, and an exoskeleton. Spiders are in a class of Arthropod called arachnids. Other types of arachnids are scorpions and ticks. Based on our observations. How many body parts do arachnids have? (2). How many legs? (8). How many eyes? (8). While all spiders have some amount of venom, there is no such thing as a poisonous spider. Who can tell me what the difference is? (Poison is ingested or absorbed, venom is injected.) Even though all spiders are venomous, most venom is not lethal or dangerous to humans. Spiders also all have glands that can produce silk, however, not all spiders use this silk to spin webs (KidZone). Let's label our spider sketches together." (put the empty spider diagram in on the document projector. Label it with Cephalothorax, abdomen, pedipalp, legs, eyes, and fangs.)

"Now that we've talked about physical observation, what are some behavioral observations. What is the spider doing? Did anyone see the spider climbing on the wall of the jar? Did any of the spiders make a web?"

What of these observations that you made (physical and behavioral) do you notice Spider-man has? We will be talking today about the ability of Spider-man to stick to walls and to make spider webs. We will wrap up by explaining a bit about what radiation really is and what would happen to a spider that was irradiated.

MAIN INSTRUCTION / ACTIVITY:

Walking on Walls:

What are some species that you know of that can walk on walls? (examples include: spiders, geckos, tree frogs, ants)

How do you think these animals are able to do this? (have students hypothesize the reasons these animals are able to walk on walls. They can write their predictions on the worksheets.

Surface Tension.

(Showing surface tension with pepper, water, and toothpick. http://www.experiments-for-kids.com/experiment-for-kids-at-home-use-pepper-to-observe-surface-tension/)

On your table, you will find a small plate, pepper, and toothpicks. Pour water in the dish. Sprinkle a liberal amount of pepper over it.

What do you think will happen when you stick a toothpick in the water? Write down your prediction on the worksheet.

Now stick the toothpick in the water so the tip is poking into the water. Write down your observations of what you see. Does anyone want to share what they saw?

Now rub dish detergent on the tooth pick. What do you think will happen when you insert the toothpick into the water? Write down your prediction.

Insert the tip of the toothpick into the water. Write down your observations.

Why do you think you saw what you did?

Who has ever heard of surface tension? Does anyone know what surface tension is?

Water molecules are attracted to each other by a molecular force called a Van der Waals interaction. These types of interactions are caused by negatively charged sides of a molecule being attracted to the positive side of another molecule. (Electrons in molecules are constantly moving. When more electrons are on one side of the molecule, that side has a slightly more negative charge and the other is slightly positive. This charge can change as electrons continue to move. The electrons in different molecules can be attracted to each other because of this polarity. A molecule side with low electrons will attract the electrons of the other molecule. Lots of electrons will repel the electrons of the other molecule causing them to move to the other side. The electrons in the molecules will switch at the same time https://www.chemguide.co.uk/atoms/bonding/vdw.html).

When the soap is added, it breaks the surface tension, in other words, it the connection between the electrons is broken. This causes the molecules far away from the toothpick to attract the water molecules making the molecules jump away from the toothpick.

Can anyone think of how this might be related to spiders walking on walls?

Sand Castles: Magic sand vs regular sand.

Who has ever made a sand castle? How do you make a sand castle?

We are going to take time to build sand castles. Each table needs a tray labeled Tray 1 and a tray labeled Tray 2. Bring both trays back to your table. One person can use the sinks to refill the 500 ml beakers with water.

Write observations of your dray trays of sand.

Now add enough water in both trays and make a small sand castle in each tray. Do not mix the sand from the two trays.

Take observations of each sand castle as you are constructing them. What do you notice?

Which sand was easier to make a castle with?

Why does one let you make sand castles and one does not? What is happening in both cases?

The water sticks to the sand in Tray 1. Each wet grain of sand sticks to other wet grains of sand because of surface tension. This allows you to form sand castles. (https://science.nasa.gov/science-news/science-at-nasa/2002/11jul_mgm)

Tray 2 has magic sand. This sand is coated with a water repelling chemical. When taken out of the water, it is dry because it “pushes” the water away from it. The water molecules that allow for castles to be built with regular sand cannot stick to magic sand. Thus, no surface tension to form bonds between the water molecules.

What do these activities have to do with how spiders and some other animals are able to stick to walls?

Scientists believe animals such as spiders and geckos use Van der Waals interactions to stick to walls. These are the same type of interactions that create surface tension, which allows for the building of sand castles.

What does this have to do with Spider-man?

Do you think these interactions would work with Spider-man and other heroes that can walk on walls?

Probably not. Van der Waals interactions are not very strong. Look at the sand with the sand castle. Add different weights to the top of your castle. How much weight can the sand castle hold? What do you think this means for Spider-man, Spider-Gwen, and Spider-Woman. These interactions work for small animals because they do not weigh very much.

End this section with the following video that explains how animals walk on walls. https://www.youtube.com/watch?v=YxN7huwdS2k As this video is shown, distribute the snack. Once this video finishes, play the next video about spider webs. (https://www.youtube.com/watch?v=W7UIagEe1iM why don't spiders stick to their own webs

As the videos are being shown and once snack is passed out, set up the video camera on a stand and hook it to the computer so that the students can see what you are doing as you are doing it.

Spider Webs:

Spider-Man can not only walk on walls, he also managed to create a synthetic spider web that he shoots out of web shooters from his wrist. Scientists have been searching for ways to create synthetic spider web for a long time because spider webs are so strong. Here is a video that shows someone making a spider-web type substance. https://www.youtube.com/watch?v=HFMmv08JyAE. Watch 0:19 – 2:27.

What do you notice about what you saw in the video? What do you think is happening? This is a chemical reaction as the two chemicals mix, a new substance is formed. This is probably a similar reaction to what Spider-man would have created to make his spider webs. However, real spiders have webs far stronger than anything real scientists (not comic book worlds) are able to create. Spider webs are one of the strongest substances for its size that are known and we have not been able to create a string like substance with the same amount of strength.

Spider webs are also interesting because they are considered non-newtonian fluids. Has anyone ever heard this term before? We are going to explore this concept to try to figure out properties of non-newtonian fluids.

Non-newtonian fluids:

http://news.mit.edu/2006/engineers-probe-spiders-polymer-art

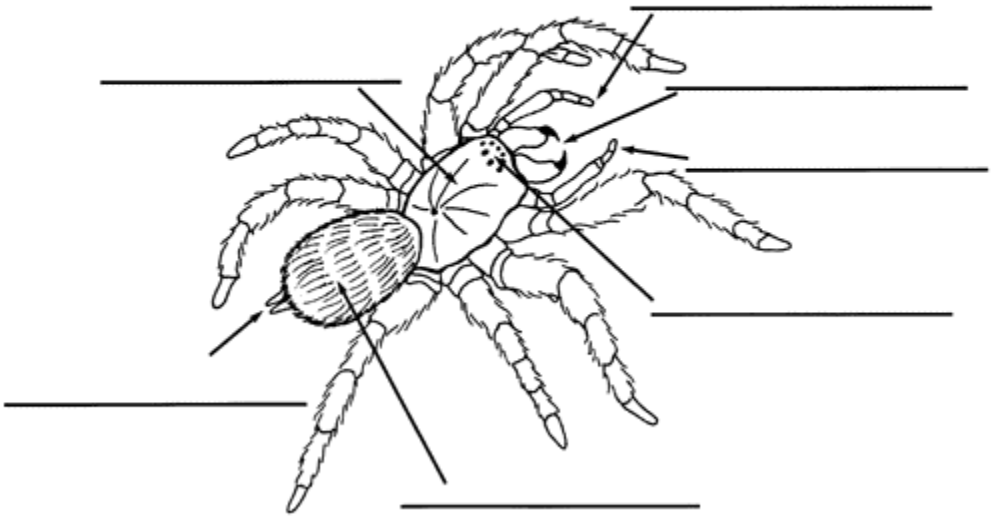
Measure 120 ml of glue. Pour it in a 500 ml beaker. Add 120 ml warm water and stir. Add 2-3 drops of food coloring. Measure 120 ml from the borax solution at the front of the room. Pour both solutions into the ziplock bag. Seal the bag and knead it. This will mix the solution together. Once the goo is mixed together, take it out of the bag and make observations about the stuff. (http://pattiesclassroom.blogspot.com/2012/06/slime-recipe-from-glue-and-borax.html). On your worksheets, write observations about what you see.

Have the students fill out the worksheets. After all students had considered what they think non-newtonian fluids are lead a discussion about their ideas. During the discussion bring up non-newtonian fluid properties. Non-newtonian fluids change their viscosity, or how liquid it is, when stress is applied. This means that if you hit it or shake it, it becomes more or less fluid (https://www.sciencelearn.org.nz/resources/1502-non-newtonian-fluids).

What similarities do you see between the stuff you made and spider webs?

Worksheets and resources:

Spider Parts



References:

https://www.cbsnews.com/pictures/spider-mans-most-iconic-moments/8/
http://www.smithsonianeducation.org/educators/lesson_plans/under_spell_spiders/lesson2.html
http://www.kidzone.ws/lw/spiders/facts04.htm

The Science of Superheroes

Week 2: Batman and Robin (And Batgirl, and Batwoman, and Oracle, and Red Robin, and Nightwing, and all the rest of Batman's associates)

OBJECTIVES:

- Understand the forces that affect projectile
- Understand how a projectile demonstrates Newton's first law of motion
- Describe encryption and the impacts on modern life
- Understand how fingerprints can be use to identify people
- Describe characteristics of scientists

STANDARDS MET:

6th Grade: 6.PS.1 Distinguish between the terms position, distance, and displacement, as well as, the terms speed and velocity.
7th Grade: 7.PS.4 Investigate Newton's first law of motion (Law of Inertia) and how different forces (gravity, friction, push and pull) affect the velocity of an object.
7.PS.7 Construct a device that uses one or more of Newton's laws of motion. Explain how motion, acceleration, force, and mass are affecting the device.
6 – 8 computer science: 6-8.PA.3 Demonstrate dispositions amenable to open-ended problem solving and programming (e.g., comfort with complexity, persistence, brainstorming, adaptability, patience, propensity to tinker, creativity, accepting challenge).
6-8.IC.1 Exhibit legal and ethical behaviors when using technology and information and discuss the consequences of misuse.
6-8.IC.2 Analyze the positive and negative impacts of technology on one's personal life, society, and our culture.

VOCABULARY:
Projectile: an object acted on by gravity
Inertia: the tendency to resist changes in the state of motion
Gravity: 9.8 m/s. the force by which a planet or other body draws objects toward its center.
Newton's first law of motion: An object in motion stays in motion and an object at rest stays at rest unless acted on by an outside force.
Velocity: the rate a projectile changes its position and the direction it travels
Trajectory: the path of the projectile
Wind Resistance: When an object hits the air molecules, these collisions can act as a force to slow the object.

MATERIALS:
Batarangs

- Cardboard
- Sheets of Styrofoam (1/2 inch thick)
- Pennies (4 per student)
- Laptop computers for each student
- Scissors
- Box cutter (only to be used by instructor and volunteers)
- Pencils
- Markers
- Construction paper

Computer Science

- Laptop computers for each student

Forensic Science

- White printer paper (2 sheets per student)
- Pencils
- Stamp pads (1 per group)
- Clear scotch tape (1 per group)
- Soft paint brushes (for fingerprint dusting) 1 per student
- glass beakers (size doesn't matter) 1 per student
- cocoa powder (1 tin, regular size from the grocery store)

TEACHING TIMELINE:

Introduction:	5 minutes
Batarangs:	60 minutes
Computer Science:	60 minutes
Forensic Science:	25 minutes

SET UP:

- before class starts, create a target. Hang the target off to the side of the room where people will not be. Block off the target area so that no one can walk in front of it.
- Prepare videos on the computer.

RULES:

3. Respect (teacher, classmates, and classroom)
4. Follow all instructions
5. During batarang activity, only throw projectile at intended target

INTRODUCTION:

Not all superheroes have super powers. In fact, for a few popular heroes, their powers are that they are rich and smart. I can think of two in particular. Who thinks they can guess who I am thinking of (Iron Man and Batman). Today we are going to be focusing on Batman and the other heroes he works with such as Robin and Batgirl.

When you think of Batman, what do you think of?
What types of things can Batman do?

What types of tools does Batman use?

Today we are going to focus on a few skills that Batman and his protégés possess.

MAIN INSTRUCTION / ACTIVITY:

Throwing Batarangs:

Show the following video: https://www.youtube.com/watch?v=3KDnrGdpNZY First Try!

A Batarang is those little bat shaped doohookies that Batman like to throw around. He uses them for all sorts of things. He can throw them and they return to his hand to knock out the bad guys. Or, like in the video we just saw, he can use them to hit a particular target like a button. But how do Batarangs work? Can something shaped like a bat be thrown with accuracy to hit a particular target?

https://www.youtube.com/watch?v=loxYbwtbDgw real batarang test.

In this video, the expert was able to throw a bat shaped object to hit the target. But lets take a look at how they are able to fly and stay on target.

The Batarang is a type of **projectile**. A projectile is an object acted on by gravity. Once thrown or dropped, it continues in its motion through its own **inertia** and influenced by gravity. Inertia is the tendency to resist changes in the state of motion. So if something is moving North, it will continue to move north unless something else changes the direction. If I roll a ball across the table, it will not suddenly change direction on its own. With a projectile, the only outside force that will cause it to change direction is gravity. Some people think that a force is needed to maintain movement. Force is only needed to start the movement and to make the object move faster (Accelerate). This is related to Newton's first law of motion that an object in motion stays in motion and an object at rest stays at rest.
(http://www.physicsclassroom.com/class/vectors/u3l2a.cfm)

Other than batarangs, what are some projectiles that you can think of? (balls, boomarangs, arrows, bullets, etc).

In the two videos we watched, the projectiles (batarangs) were used to hit a particular target. When using a projectile to hit a target, what are some things that should be considered? What might affect your ability to hit the target? Accuracy is how close you get to the standard

(http://webphysics.iupui.edu/NH/Projects/TEAMS%5B2%5D/err6.htm). In the Lego Batman clip, accuracy would be hitting the center of the button. Do you think the Lego Batman was accurate? Why? What could have affected his accuracy, other than his aim? (Some suggestions could be: distance to the target, mass of the projectile, velocity, angle, shape of the object. Write suggestions on the whiteboard as they are stated. If you have a classroom aide, that person can write on the board for you.)

We are going to create our own Batarangs to try to hit a target. You are going to act as Batman or Batgirl. Joker has escaped from prison. You have been trying to apprehend him but he set off a trap which made the floor between you and the Joker sink into a pit of lava. In order to put the floor back, you need to hit a button. The only problem is that the button is on the other side of the lava! Create a batarang that will allow you to hit the button with accuracy. You have to hit it on the first try! As you create your Batarang, keep each of these things (the factors written on the board) in mind as you create your design.

Students can use the provided items to create their batarang. They will have **35 minutes** to create their Batarangs. They can test different sizes, shapes, materials, and weights. Students can use pennies to adjust weight of their projectile. They can experiment with the location of the pennies on the projectile. Students cannot use more than 4 pennies. If students want to test batarangs as they are constructing them, they can do so only is the target area. Have one volunteer monitoring the target area to ensure that no student walks in front of a testing batarang. Have the target area off to the side of the room or in a separate hallway. As students are creating their batarang, they can take notes in the worksheet about what they are making and why they are making it that way.

Once students have created their batarang, each batarang will be weighed and the weight will be added to the worksheet. Each student from each group will have the opportunity to throw their batarang at the target. The distance from the target will be measured and recorded in the worksheet. The average distance from the target will be calculated for each group. This average distance will represent the accuracy of the batarang. The accuracies will be compared between groups. The class will compare what the different batarangs look like. What could have contributed to the most accurate batarang and why? (Because there could be different attributes, different factors may come up in discussion. The following are the likely physics aspects that may be discussed. They may not all be covered in the class discussion):

Velocity: the rate a projectile changes its position and the direction it travels. It is measured the same way as speed. how fast it travels horizontally does not change. How fast it changes vertically does change due to gravity. The velocity can determine how far a distance the projectile travels http://www.physicsclassroom.com/class/1DKin/Lesson-1/Speed-and-Velocity

Gravity: 9.8 m/s. Gravity acts on projectiles and brings them closer to the ground.

Angle: The degrees between how two lines intersect.

Trajectory: the path of the projectile (https://physics.info/projectiles/)

The shape of the object might affect wind resistance. When an object hits the air molecules, these collisions can act as a force to slow the object. A larger surface area of the edge can lead to hitting more air molecules. (https://www.universetoday.com/73315/what-is-air-resistance/)

If there is time or a group gets done early, they can play the following computer game. Gorilla game with exploding Bananas https://classicreload.com/qbasic-gorillas.html

Computer Science:

https://www.youtube.com/watch?v=lueD1r-DkNg hacked the motion sensors

Batman, and all of the Bat family do not have super powers, so they make up for it with athletics and intelligence. They are not only experts and different combat techniques, they are also experts with computers. But of all the members of the Bat clan, Oracle is probably the best with computers. She is able to hack anything and get any information that the heroes of Gotham need.

Knowing how to use a computer is not only useful for Oracle, but it is also useful for all of us. Knowing how to create codes and navigate computers are important skills. One computer skill is called encryption. This is where a message can be changed to be unreadable. De-encrypting it allows for the coded message to be readable again.

The Scenario: Oracle, the former Batgirl has intercepted an encrypted message that the Joker sent out to all the other villains in Gotham. He is planning something big, but what is it? Help Oracle de-encrypt the message so she can send it to Batman.

https://studio.code.org/s/hoc-encryption

Complete the activity on the website

Using the website, students should create their own encrypted message, switch with a partner and try to figure out each other's encryption.

After the activity, discuss the following:

- How do you use computers in your own life?
- Have you ever used encryption?
- In what ways do you think understanding encryption can help with your own life?
- What is the relevance of encryptions?
- What ways can you think of that people use encryptions?
- What ethical issues do encryption programs and de-encryption programs possess?

Snack time:

During snack show the following videos:

https://www.youtube.com/watch?v=gchaCA-HTeU&list=PL63842C648280D256 - science of batman documentary minutes 0:00 - ?

https://www.youtube.com/watch?v=xqE2pi4_29s - science of batarangs
https://www.youtube.com/watch?v=WZL7OpFq0fw – scishow fingerprints

Forensic Science:

Batman is sometimes called "The World's Greatest Detective." In what ways are detectives similar to scientists?

Who has ever seen a television show about detectives or criminal investigators like CSI or NCIS? What are some things that the characters on these shows do to solve the crimes?

One way to determine who has committed a crime is to look for fingerprints at a crime scene and then try to match them to the fingerprints of a suspect.

Let's see how it works. First we will take our own fingerprints and look at the patterns there.

Each person should get one piece of paper. They should write their name at the top of the paper. Roll each finger lightly in the ink pad and then roll it on the paper. Underneath, identify which finger and which hand it came from. Do this for all ten fingers and then wash your hands in the sink.

Look at your fingerprints. What sorts of patterns do you notice? What do your fingerprints look like?

There are three main patterns of fingerprints, an arch, a loop, and a whorl. (http://www.odec.ca/projects/2004/fren4j0/public_html/fingerprint_patterns.htm; https://www.researchgate.net/figure/11673949_Figure-1-Basic-fingerprint-patterns-a-the-arch-is-the-simplest-of-all-the-configurations-b) Show pictures of each type to the students. Ask them what they notice about what each type looks like. Once students are able to identify the three types. Have then categorize their own fingerprints. Create a booklet with the group's fingerprints and put it off to the side.

So where do our fingerprints come from? Ask students where they think fingerprints come from. Do identical twins have the same fingerprints, why or why not? (https://www.livescience.com/30-lasting-impression-fingerprints-created.html). Our skin has three different layers. The middle layer grows faster than the top and bottom layer. This force causes the skin to buckle and form complex patterns. Because the patterns are formed by different forces, each person has a different pattern that forms. The patterns are physical, not genetic.

Because everyone has unique fingerprints, we can be identified by them. Criminal investigators can dust for fingerprints and then compare them to a database. In front of you are glass beakers. Each person will press one of their fingerprints to the glass beaker, about half way down, across from where the numbers are. Without touching the area you put your fingerprint, switch beakers with the group across from you. Carefully mix them up so that you do not know which beaker came from which person. Also give them your booklet of identifying fingerprints.

Each person should take one of the traded beakers, being sure not to touch the area where the fingerprints are. Only touch the beakers at the top rim. Sprinkle the fingerprint area with cocoa powder. Take one of the brushes and very gently brush away the extra powder. The powder touching the fingerprint will remain. Place the tape over the powdered fingerprint and

then place it on a sheet of paper. Look through the booklets from the other group and try to identify who your fingerprint came from by looking for the patterns.

After all students have identified the fingerprints of the other group, discuss applications.
How is this applicable to real life?
What are the benefits of using fingerprints to identify people?
Are there any problems from this method?
What skills did you practice that you think real life detectives do?
What are other jobs that use similar skills?
What are some ways detectives are similar to scientists? How do they both use… observation? Inferences? Data? Problem solving?

Fingerprint activity: http://stem-works.com/external/activity/561

REFERENCES:

https://spaceplace.nasa.gov/what-is-gravity/en/

http://www.physicsclassroom.com/class/1DKin/Lesson-1/Speed-and-Velocity

https://www.youtube.com/watch?v=3KDnrGdpNZY

https://www.youtube.com/watch?v=loxYbwtbDgw

http://www.physicsclassroom.com/class/vectors/u3l2a.cfm)

http://webphysics.iupui.edu/NH/Projects/TEAMS%5B2%5D/err6.htm

https://physics.info/projectiles/

(https://www.universetoday.com/73315/what-is-air-resistance/

https://classicreload.com/qbasic-gorillas.html

https://www.youtube.com/watch?v=lueD1r-DkNg

https://studio.code.org/s/hoc-encryption

http://www.odec.ca/projects/2004/fren4j0/public_html/fingerprint_patterns.htm

https://www.livescience.com/30-lasting-impression-fingerprints-created.html

: http://stem-works.com/external/activity/561

The Science of Superheroes

Week 3: X-Men and other mutants

OBJECTIVES:

STANDARDS MET:

8th Grade: 8.LS.5 Explain how factors affecting natural selection (competition, genetic variations, environmental changes, and overproduction) increase or decrease a species' ability to survive and reproduce.
8.LS.9 Examine traits of individuals within a species that may give them an advantage or disadvantage to survive and reproduce in stable or changing environment

VOCABULARY:
Mutation – A change in DNA
Evolution – A change in a species over time. Takes generations for evolution to occur. Can occur due to beneficial mutations, natural selection, or sexual selection.
Natural Selection – animals with traits that are best suited to their environment, tend to survive to pass on those traits. Traits that are detrimental tend to cause the animal to die before it can pass on the traits.

MATERIALS:
Mutations

- Pencils
- Small notepads of paper (1 per student).

Genetic inheritance

- Worksheets
- Scissors
- Clear tape or glue sticks
- Markers, crayons, or colored pencils

Natural Selection Activity:

- Colored Construction Paper
- M&M's (100 per group- 400 total)
- Ziplock baggies (8)
- pencils

Human evolution

- worksheets

- pencils
- markers, crayons, or colored pencils

CLASS SET-UP:
Prepare 8 baggies with 50 M&Ms in them. Each baggie should have equal amounts of each color.

TEACHING TIMELINE:

Introduction:	5 minutes
Mutations	45 minutes
Genetic Inheritance	30 minutes
Snack break	10 minutes
Natural Selection	30 minutes
Human evolution	25 minutes

RULES:

6. Respect (teacher, classmates, and classroom)
7. Follow all instructions

INTRODUCTION:
Start with the X-Men movie introduction. https://www.youtube.com/watch?v=3FOMgYw-a5I Evolution leaps forward, Intro clip from X-men movie (2000)

Today we will be talking about some of my favorite superheroes: the X-Men. The X-Men are a group of heroes that were born with their abilities due to mutations. According to the video clip we just watched, evolution sometimes leaps forward.

- This works for comic books and movies, but does it work in real life? What do you think?

Today, we are going to investigate this process of evolution.

- How many of you know a mutant? (if anyone raises their hand, ask for them to explain?)
- How many of you are a mutant? (again, ask for explanations)

Lets watch a video that tells us a little bit about a certain mutation.

https://www.youtube.com/watch?v=ecZbhf96W9k Milk mutations Scishow video

- After watching the video, how many of you would now say that you are a mutant?

MAIN INSTRUCTION / ACTIVITY:

- Who thinks that they can define the word mutation?

Mutations

We are going to investigate how a mutation might work by playing a game. Has anyone ever played the game Telestrations?

- To start this game, we will get into two groups (about 6 people per group)
- In this game, you will each get a pad of paper. The front page of the paper has a word or phrase written on it. You need to turn the page and draw that word on the next paper.
- Turn your pad upside down so no one else can see what you drew and hand it to the person next to you on your left.
- Look at the picture the person drew. Flip the page and write what you think this is.
- Again pass it to the person on your left.
- Look at the word that was written and draw that word on the next page. Flip the page and pass the notebook to your left.
- Look at the picture and write the word of what you think it is.
- Pass it to your left
- Look at the word and draw the picture
- Continue in this pattern until you get your original notepad back.
- Go around the table and share what the original word was and then flip the pages to see if and how it changed.

Discussion:

- Were there any changes from the original word to the final word?
- How many people's words changed by the end of the game? How many did not change?
- What are some examples of changes that occurred?
- Did any of the words and pictures match at the end of the game (did not change)?
- Why do you think that some words changed and some did not?
- What do you think this has to do with mutations?
- How many people have heard of DNA? What is DNA? Deoxyribose Nucleic Acid. This is the genetic material of living things as we know them. As we grow, and as new cells are created, our DNA copies itself and a new copy goes in each new cell. Sometimes, when the DNA gets copied, it doesn't copy quite right. There could be a mistake in the new copy. This means that the new DNA is slightly different than the original. This might have no effect, or it might have a really big effect.
- How is the activity we just did similar to how DNA copies itself?
- How do you think this relates to evolution?
- If one person develops a mutation in DNA in their finger, will that be passed on to their offspring? No, only the DNA in the reproductive cells are passed on to the kids. Generally the traits that an individual is born with are the traits that are passed on to the offspring.

Genetic Inheritance.

Lets examine a bit how different traits might be passed on to an animals kids.

On your table, you will see papers with different animal body parts. You will cut and paste the different body parts to make a complete animal.

Once the animal is completed, pick a partner. The animals that each of you created will breed. You will create what you think the offspring of the animals will look like. You can only use the same type of body parts that the parents had. The new offspring cannot have characteristics that were not seen in at least one of the parents.

Discussion:

- How did you decide what the offspring looked like?
- Were there any body parts that were the same between the two original animals?
- If there were two different options, how did you decide what the offspring looked like?
- If kids tend to have the same traits as their parents, how do you think that would affect evolution as seen in the X-men? How would genetic inheritance affect the variety of powers seen in the X-Men?

Snack:

https://www.youtube.com/watch?v=QNJkcr7u2TY the truth about gingers scishow video
https://www.youtube.com/watch?v=tV1-fO4nUek wolverine's claws. Because Science.

Natural Selection:

We have seen how mutations are formed as DNA gets errors when it copies itself. We have also seen how traits are passed from parent to offspring and that without random mutations, offspring do not develop random traits that the parents did not have. That is all at the individual level. Now lets look at how populations can change over time. A population is a group of the same species in the same area where there is gene flow. That means that they are capable of reproducing with each other. There is nothing preventing them from breeding.

1. Each of you will get a different colored piece of construction paper.
2. On your worksheet, write down what color you have.
3. You will now get a bag of M&Ms. Do not eat the candy.
4. Dump your bag of M&Ms on the paper, be careful to keep all the pieces of candy on the table.
5. Count how many of each color you have and write it down on the worksheet in the first column.
6. Make sure the candies are randomly mixed on the page. Don't have them grouped by color.
7. In five seconds, pick out the as many candies as you can, one at a time. Pick the ones that you first notice.
8. Count the remaining colors and write the new numbers on the worksheet in the second column.
9. For every two of the same color, add one more of that color from the other M&M baggie.
10. Write the new numbers of each color in the third column.
11. Repeat steps 4-10
12. On the worksheet write what you noticed about the M&M population. How have the colors changed?

13. Now take a different color of paper and transfer your population of M&Ms onto the new background.
14. Repeat steps 6 – 12
15. What happened when the background changed?
16. What does this activity tell you about natural selection?
17. What role do you think the environment has on natural selection?
18. How do the three activities we have done so far relate to each other? What role do mutations play in natural selection? How do traits passed from parents relate to natural selection?
19. What does all this mean for evolution?
20. What does it mean for the X-Men?

Mutations and Super Powers

Watch the video, the future of human evolution:
https://www.youtube.com/watch?v=tNjsVTQ7Q3c

Mutations are responsible for new genetic information. They are also responsible for diseases such as cancer, sickle cell anemia, or cystic fibrosis

- Do you think that mutations are a good thing or a bad thing? Why?
- Do you think that mutations can give a person super powers?
- How would you define a superpower? Would the ability to drink milk without getting sick be considered a superpower?

Evolution for humans usually takes thousands of years because it has to involve many generations. While it may be possible for one human to evolve an ability we do not currently have, The chances of it becoming widespread in a population will take a very long time

Based on what you learned about natural selection and evolution, what do you think the future of humanity looks like? On the worksheets, draw a picture of how you think humans will evolve to better survive in our environment. Explain why you think that

Share your drawings and your explanation of why you think humans will look or act that way.

References:

http://genetics.thetech.org/about-genetics/mutations-and-disease

The Science of Superheroes

Week 4: The Flash

OBJECTIVES:

STANDARDS MET:

6th Grade: 6.PS.1 Distinguish between the terms position, distance, and displacement, as well as, the terms speed and velocity.
6.PS.2 Describe the motion of an object graphically showing the relationship between time and position.
7th Grade: 7.PS.4 Investigate Newton's first law of motion (Law of Inertia) and how different forces (gravity, friction, push and pull) affect the velocity of an object.
7.PS.8 Investigate a process in which energy is transferred from one form to another and provide evidence that the total amount of energy does not change during the transfer when the system is closed. (Law of conservation of energy)
7.LS.4 Research and describe the functions and relationships between various cell types, tissues, and organs in the immune system, circulatory system and digestive system of the human body.

VOCABULARY:
Newton's first law of motion: an object in motion stays in motion and an object at rest stays at rest unless acted on by an outside force
Velocity: how fast an object changes it s position in a particular direction. It is direction aware
Speed: how fast an object is moving. The amount of time it takes to cover s certain distance
Friction: force exerted by the surface as an object moves across it. It results from two objects pressed together.
Metabolism: chemical reactions in the body that allows molecules of one type to be converted to another for storage or immediate use in another reaction, or as waste. It is used for cell growth, reproduction, and energy. One common example is the process of food being converted to energy and then used for various purposes in the body.
Heat: caused by atoms moving quickly

MATERIALS:
Velocity and Speed

- A variety of different types of balls (marbles, hacky sacs, golf balls, pingpong balls, baseball, tennis ball, bouncy ball, etc) a couple of each type.
- Stopwatch (1 per group)
- Boards or planks to act as a ramp (1 per group)
- Books to create ramp angle (2-3 books per group. We can probably just grab them from the shelves in the room)
- Pencils (1 per student)

- Worksheets
- Yard sticks (1 per group)
- Masking tape or some other colored tape to mark on the floor (1 roll per group)
- Calculators (1 per group)

Friction

- Pingpong balls (2 per group)
- Sand paper (2 piece per group
- Cotton cloth (a sheet or pillowcase would work (1 per group)
- Wool cloth if easily available
- Nylon cloth if easily available
- Leather cloth if easily available
- Cloth hand towels (1 per group)
- Printer paper (3 pages per group)
- Construction paper (3 pages per group. Any color)
- Boards or planks for ramps (1 per group)
- Books to create ramp
- Pencils (1 per student)

Metabolism and Exercise

- Worksheets
- Pencils (1 per student)
- Measuring tape (up to 100 feet) I actually have one in my desk so you don't need to worry about finding it if there isn't one in the materials room.
- Stop watch (1 per group)

CLASS SET-UP:

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TEACHING TIMELINE:

Introduction:	5 minutes
Velocity and Speed	45 minutes
Friction	45 minutes
Metabolism and exercise	50 minutes

INTRODUCTION:

How many of you have ever seen the TV show the Flash? This character is considered the fasted man on earth and can run faster than the speed of light, which is 299,792,458 meters per second or 186000 miles per second.

What are fastest animals? Cheetah: ~ 65-75 miles per hour, Falcon: 240 miles per hour, in contrast, the fastest human ran at 28 miles per hour. Average human running speed (for adults at peak fitness) is 10-15 miles per hour. Men tend to run faster than women.

https://www.youtube.com/watch?v=z4O-5eV4LiA
how fast the flash is watch until 4:30.

MAIN INSTRUCTION / ACTIVITY:

Speed

We talked a little bit about how fast different animals can run. Let's examine some factors of what makes things move at different speeds. We will compare the speed of different types of balls going down a ramp.

First, construct your ramp. Use some books to make a ramp at a certain height.

Choose three different balls

On your worksheet, predict which ball you think will go the fastest and why

Measure out three feet from the end of your ramp and mark it with a piece of tape

Allow each ball to roll down your ramp, one at a time. Time how long it takes each ball to pass the tape. Test each ball three times and record the time in your worksheet.

Calculate the speed of the ball by averaging all three times. Speed will be calculated in distance per second. Divide the distance travelled by the number of seconds it took. This will be your speed for example, if it took 5 seconds to travel 3 feet, I will divide three by five. This will result in .6. This means my speed was .6 feet per second. In other words, it traveled .6 feet (about 7 inches) every second.

On your worksheet write which ball went the fastest

On your worksheet, write why you think it went the fastest.

What do you think affected the speed of the balls?

- Smoothness
- Weight
- Gravity
- Height of the ramp
- Friction

Friction

One thing that affected the speed of the balls was friction.

- What is friction?

Everyone rub your hands to together for ten seconds. Go as fast as you can. Now place your hands on your cheeks

- What do you feel?
- Why does it feel warm?

The heat was caused by friction. Friction is a force that occurs when two surfaces rub together. In order to understand why friction causes heat, you need to see that heat is caused by the atoms in an object moving quickly. When two substances press and rub together, it causes the atoms in the objects to move faster and faster, which causes heat.

Watch this video https://www.youtube.com/watch?v=L4jh6DQc7AU this shows how fires can be started with rubbing wood together.

- What did you see in this video?
- What do you think that would mean for the Flash (or his shoes)?
- As we saw in the earlier video, flash can run so fast that the friction with the air molecules would cause a nuclear explosion. In order to prevent this, the Flash would need a way to limit friction. Do you think that there is a way to do this? Lets test it out with the different balls

Testing Friction and materials

Choose your fastest ball and two different materials to cover your ramp.

On your worksheet, predict which material will have more friction and which will have less.

Test your prediction by covering your ramp with each material and running your experiment again. Rolling the ball down the lamp, averaging the time it took to go three feet, and then calculating the speed.

Because friction also causes things to slow down, the faster speed would have less friction.

On your worksheet write which material had less friction and why you think so.

Class discussion about which materials had less friction.

- What were some characteristics of less friction?
- Why do you think those characteristics are important for limiting friction?
- Why do people slip on ice?

Snack:

During snack, show the following videos:

https://www.youtube.com/watch?v=N6pwp4u3xTw Start at 29:21 – 34:24. Talks about how fast a cheetah can run and adaptations they have

The first is from the TV show. It is right after he gets his powers and he keeps passing out. https://www.youtube.com/watch?v=OTXmLZ43Tm0 In the end of the videos, they mentions glucose levels.

- What is glucose? It is sugar that helps give us energy. If we don't have enough energy, we can't function.
- How do we get energy in our bodies? We eat. Energy from our foods allow us to burn energy. As we burn more energy, it affects our heart rates, breathing rates, and other things in our body We know that the Flash goes through a lot of energy when he runs. What happens in our own bodies when we run?

Metabolism and exercise

On the worksheet, record your heart rate. Find your pulse on your wrist. If you can't, then put your hand over your heart on your chest.

Count the number of beats as your partner times thirty seconds. After thirty seconds write the number on the paper. Use the calculator to double the amount in order to get your beats per minute.

Now count your respiration. Count how many breaths you take as your partner times out thirty seconds. Double it to determine your breaths per minute

We are now going to see how fast we can run.

Go downstairs in the hallway or outside if it is nice. Measure out 100 feet.

Have students find a partner. One person of the group will run as fast as they can the 100 feet. Their partner will time them. Immediately following the run, they will calculate their breathing, and heart rate. Students will repeat the process three times and then switch partners

Once all students have run, they will convert their speed into feet per second by dividing the number of feet by the number of seconds. They will then use the internet to find how many miles per hour they were able to run for each trial.

Students will create graphs that show their speed, heart rates, and breathing rates.

Students will write on their worksheets how their speed affects their bodies.

- How fast were people able to run?
- How did your speed affect your body?
- Was your breathing and heart rate different before you ran than after?
    - How was it different?
- Why do you think it was different?
- What do you think this has to do with metabolism?
- What do you think this means for the flash?

References:

http://www.physicsclassroom.com/class/1DKin/Lesson-1/Speed-and-Velocity

https://www.iamlivingit.com/running/average-human-running-speed

http://www.physicsclassroom.com/class/newtlaws/Lesson-1/Newton-s-First-Law

https://www.biology-online.org/dictionary/Metabolism

https://www.youtube.com/watch?v=pGJWD15MqGU

The Science of Superheroes

Week 5: Superman, Supergirl, and Krypto the Super-dog

OBJECTIVES:

STANDARDS MET:

6th Grade: 6.PS.4 Investigate the properties of light, sound, and other energy waves and how they are reflected, absorbed, and transmitted through materials and space.
6.ESS.3 Compare and contrast the Earth, its moon, and other planets in the solar system, including comets and asteroids. (Comparisons should be made in regard to size, surface features, atmospheric characteristics, and the ability to support life.)
7th Grade: 7.PS.9 Compare and contrast the three types of heat transfer: radiation, convection, and conduction.

VOCABULARY:

MATERIALS:
Super Hearing

- Measuring Tape
- 3 traffic cones or some other large, noticeable object that can be seen from a short distance to mark a location.
- Paper, 1 per student
- Pencils 1 per student

Alien Life

- Worksheets (1 per student)
- Pencils (1 per student)
- 300 ml beakers (3 per group)
- Soil/sand mixture (50 ml in each beaker)
- Sugar (5 ml in each beaker)
- Yeast (5 ml in 1 beaker per group)

- Crushed alka-seltzer pellet (1 for one beaker in each group)
- Hot plate
- 1000 ml beaker filled with water
- 250 ml beaker (1 per group)
- Hand lens (2 per group)
- Dessert sized disposable plates (2 per group)

Bottle Rockets

- Empty water bottles (500 ml) (1 per group)
- Vinegar (250 ml per group)
- Baking soda (1 box)
- Corks (1 per group) need to be a size that will fit the top of the water bottle
- Unsharpened pencils (3 per group)
- Duct tape (1 roll)
- Thin cardboard or cardstock to make "wings" on the rocket
- Pencils
- Protractors (1 per group)
- String (1 roll)
- Metal washers (1 per group) size doesn't matter
- Worksheets
- Saran wrap (1 roll)
- Rubber Bands (2 per group)

CLASS SET-UP:

.

TEACHING TIMELINE:

Introduction:	10 minutes
Super hearing:	30 minutes
Alien Life	30 minutes
Bottle Rockets:	80 minutes

RULES:

8. Respect (teacher, classmates, and classroom)
9. Follow all instructions

INTRODUCTION:

This week, we will be talking about Superman and Supergirl. Who knows where these two heroes come from? They come from a fictional planet called Krypton. When the planet was dying, they were sent in a rocket to earth for safety.

Can anyone think of any other superheroes that are from other planets?

What are some of the powers Superman and Supergirl have?

How are they able to do these things?

- Superman is able to do all that cool stuff because he gets energy from the sun.
- What are ways that we use energy from the sun?
- https://www.youtube.com/watch?v=4VlXGA1FnSk how does our skin turn sunlight into vitamin D. So not only Superman uses the Sun to be super strong. We use the sun to strengthen our bones.
- What are other ways we use energy from the sun?
    - Heat transfer. Energy from the sun is felt as heat. The heat energy can be transferred to warm the earth
    - The energy can be absorbed in solar panels. We can then use the energy to power our electric devices

MAIN INSTRUCTION / ACTIVITY:

1. Super Man's Super hearing:
    a. One power that Superman and Supergirl have is that they are able to hear very well. They can hear people calling for help from very far away.
    b. What types of animals hear well?
    c. How good is our hearing? Let's test it out. Go outside and have everyone stand in a line, shoulder to shoulder. Stand about 10 feet in front of them and explain what you are going to do. Place one bucket at your starting point.
    d. Have the students close their eyes and keep their hands at their sides. Have one student hold the end of the measuring tape. Walk backwards and talk softly to them about anything, unrolling the measuring tape as you go. You can also count or recite words. Tell

students that when they can no longer clearly hear each word you are saying, to raise their hands. Once about half of the class has their hands raised, you can tell them to open their eyes and see how far away you are. Place a second bucket at your location and go back to the first bucket.

e. Tell them that you are going to do the same thing, but this time, they need to cup their hands around their ears. They should make their hands like spoons, with fingers together, and place both hands behind their ears, but not covering their ears.
f. Walk backwards talking again, unrolling the measuring tape) and have them raise their hands when they can no longer clearly hear the words you are saying. Once about half the class raises their hands, you can have them open their eyes. Look at the distances.
    i. Which time were you able to get further away? Why?
    ii. Why did holding your hands around your ears allow for better hearing?
    iii. How does the size and shape of an ear affect hearing?
g. Superman can pinpoint one call for help when listening to a whole city. Can you? Play a tone for the students. Then play a bunch of other noises and play the tone periodically. Half the class close their eyes and raise their hands when they hear the tone. The other half count how many people raise their hands at the right and the wrong time. Then switch.
    i. How easy was it to hear one sound when there were a bunch of other sounds?
    ii. How do you think this would affect Superman's ability to pinpoint exactly where a call for help is coming from?
    iii. How does sound travel?
        1. Sound travels in waves.
    iv. What happens when the waves from one sound hits the waves from another sound?
        1. If you have a pond and throw a rock in it, what happens to the surface? You get ripples. What if you throw a second rock in it? What happens to the ripples when the they meet?

h. Superman is not only hearing lots of sounds, he also is in an area with lots of buildings. How do structures affect sounds?
i. Sound identification. A variety of sounds are played. Students need to identify the sound. Some examples could include Velcro, a chainsaw, rain, a horse, an elephant, footsteps, typing on a key board, etc.
j. How do we identify what each sound comes from?

2. Alien Life
    a. Superman and Supergirl are fictional aliens. But do you think that there are any real aliens? Why or why not?
    b. What does a planet need to support life?
        i. Water
        ii. Atmosphere
    c. Each sun has what is called a habitable zone. This is the area where liquid water would be able to exist. Earth is within our planet's habitable zone. Are there any other planets within our sun's habitable zone?
        i. Mars
        ii. Venus
    d. Has anyone heard about the explorations of Mars? What are some things that NASA scientists are investigating on Mars?
        i. Geography (rocks)
        ii. Climate
        iii. History
        iv. Water
        v. Life?
    e. When scientists get samples of dirt from Mars, they want to uncover if there is any life in the soil. What types of things might they look for?
    f. What are characteristics of life? How do we know if something is alive or not? (Write responses on the dry erase board).
    g. Do the following activity from NASA: In this activity, students are given three soil samples and need to determine if there is life in the samples based on the criteria that was talked about. One cup has alka seltzer pellets (no life), one cup has yeast (life), one cup has sugar (no life)

i. Students can use the hand lenses to investigate the contents of each jar while they are dry
ii. Students can add warm water and see if there are any reactions (there will be reactions in the jar with alka-seltzer and yeast. Discuss what they notice. (Write observations on their worksheets) Sample with the alka-seltzer will have a short reaction and then stop. The reaction with the yeast will be longer.
iii. Both of these are chemical reactions. One is life, and one is not. How can we tell the difference?

https://mars.nasa.gov/mer/classroom/pdfs/MSIP-MarsActivities.pdf#page=36

3. Bottle Rockets
    a. In order to get to earth, Supergirl, Superman, and any other alien would need to travel through space. They use rockets to do this.
    b. What do rockets need?
    c. How are rockets launched into space? (https://spaceflightsystems.grc.nasa.gov/education/rocket/combst1.html)
        i. Rockets need thrust: 3rd law of motion, with every action there is an equal and opposite reaction. As a gas is propelled out, it forces the rocket forward.
        ii. Combustion: a chemical process where a fuel reacts with oxygen to produce heat.
    d. https://frugalfun4boys.com/2016/04/14/epic-bottle-rocket-flew-higher-2-story-house/
    e. https://www.sciencebuddies.org/science-fair-projects/project-ideas/Chem_p086/chemistry/rocketology-baking-soda-vinegar-lift-off#summary
    f. https://teachbesideme.com/quick-bottle-rockets/
    g. We are now going to create rockets and see how high they go, although we won't be using combustion. We will be using a different type of chemical reaction to produce thrust.

h. Students will construct bottle rockets using 500 ml water bottles, cardboard or cardstock for wings and cones, corks, and tape. They will use baking soda and vinegar to produce thrust.
i. Students construct and design their rocket however they want. All rockets must have 3 pencils as "legs" to hold the rocket in an upright position. The opening of the bottle is the bottom of the rocket.
j. Once constructed, they will pour 250 mls of vinegar in the bottle.
k. They will create baking soda pellets by adding 1 Tablespoon of baking soda in a paper towel. They will fold the paper towel around it so that the baking soda will not fall out. This will be kept separate from the bottle until the last minute.
l. Students will also tie a string to a protractor and then a washer to the other end of the string. They will take this with them when they go outside.
m. Once rockets are constructed, the class will go outside to test them to see which rocket flies the highest.
n. Just before launch, students put the baking soda in the bottle, seal it with the cork, and step back
o. Students will calculate height using a protractor with a string in order to see the angle of the highest point.
p. Once all rockets flown and data recorded on their worksheets, class returns inside
q. Discuss which rocket flew farthest and why.
    i. Talk about thrust, wind resistance, third law of motion
r. How people (or kryptonians) can travel through space. https://www.youtube.com/watch?v=H7tU0H6rD-g scishow: warp drives. https://www.youtube.com/watch?v=MTTl1DNqQ6g scishow: the truth about warp drive.

Worksheets and resources:

References:

https://www.grc.nasa.gov/www/k-12/airplane/newton.html

https://www.sciencelearn.org.nz/resources/300-wings-and-lift